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Ruminant Magic

Forage crops have traditionally been the orphans of the agricultural scene. Farmers and ranchers do not lavish the same care on them as on cash crops. This benign neglect will change, however, if world population growth forces people to compete with livestock for grain.

Bleak forecasts of a gastronomic future with meatless meals keep appearing in the press, but few writers adequately assess the role of forages in livestock production. It was an ancient role when some early farmer even thought of feeding grain to his flock. For ruminants such as cattle and sheep are superbly endowed to thrive on forages—pasture and harvested herbage—converting fibrous materials that people cannot eat into protein-rich meat and milk. Indeed, forages account for about 70 percent of the nutrients that beef cattle consume over their lifetimes. This is a notable statistic because over half the total U.S. land area—about a billion acres—is fit not for cropping but for producing forage.

The dark of a cow's rumen harbors immense Lilliputian armies of microbes that digest and mobilize nutrients for the cow to assimulate. Some microbes digest cellulose, others make vitamins like the B-complex, still others make digestible proteins for the ruminant, either from nonprotein nitrogen present in forages or that fed as urea.

The ruminant's "fermentation vat" not only digests forages, but also wastes from the processing of food for human consumption. These include byproducts from preparing flour, starch, sugar beets, and distillery products as well as rendered wastes from the meat packing industry.

An even larger source of feed, one still to be exploited, lies in the mountain of high-fiber wastes produced each year, particularly straw. If this byproduct of grain production could be rendered digestible, it could maintain three times the present number of U.S. dairy cattle.

Although ruminants are primarily consumers of forages, even limited protein supplementation improves their performance in feedlots or dairy parlors. So rationed, they produce more protein than they are fed. With advances in research, their future protein needs could be met through feeding nonprotein nitrogen sources such as urea, especially with low-quality forages.

Agricultural science is helping us get more out of our great forage resource. But we need more public awareness, a stir of forage consciousness throughout the world. For whatever enhances the fruitful meeting of ruminants and forages also bolsters mankind's supply of protein feedstuffs.—*R. P. K.*

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COVER: Within-row irrigation can reduce water use for bean farmers in semi-arid areas by 30 to 50 percent over conventional techniques. These beans, grown in furrows at the Snake River Conservation Center at Boise, Idaho, are receiving their first irrigation after planting (0874X1357–15). Article begins on page 14.

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Earl L. Butz, Secretary
U. S. Department of Agriculture

Talcott W. Edminster, Administrator
Agricultural Research Service

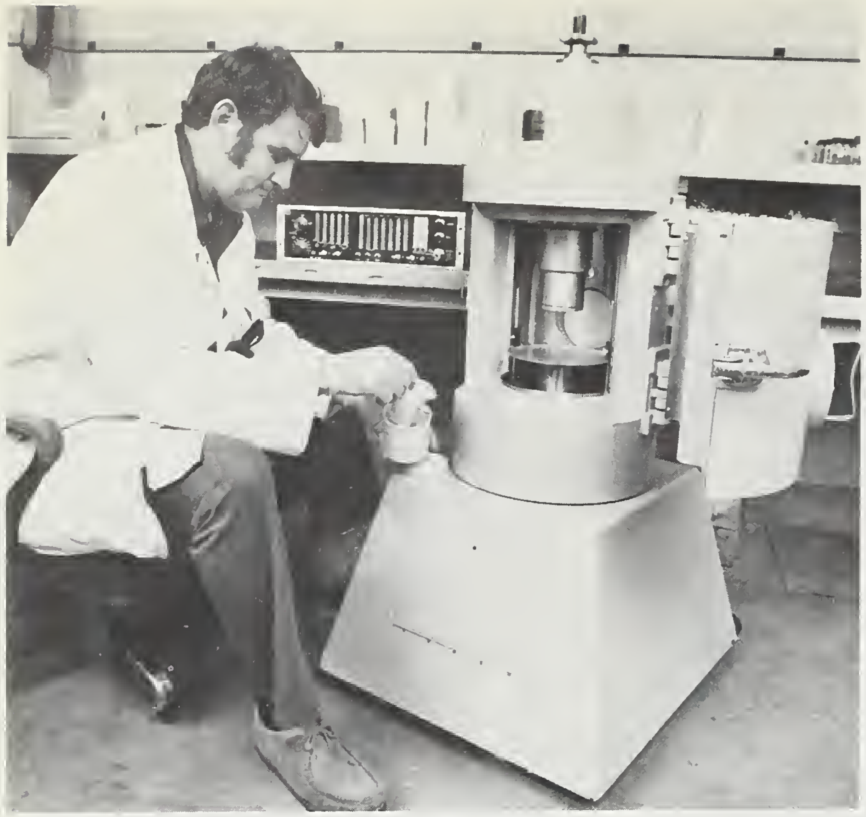
Dr. Welch adds radioactive isotope of zinc to the nutrient solution nourishing mature bean plants. Plants grown with radioisotopes are harvested, homogenized or cooked, and fed to laboratory rats. The rats' isotope intake and excretion are carefully monitored (0875X1166–12).

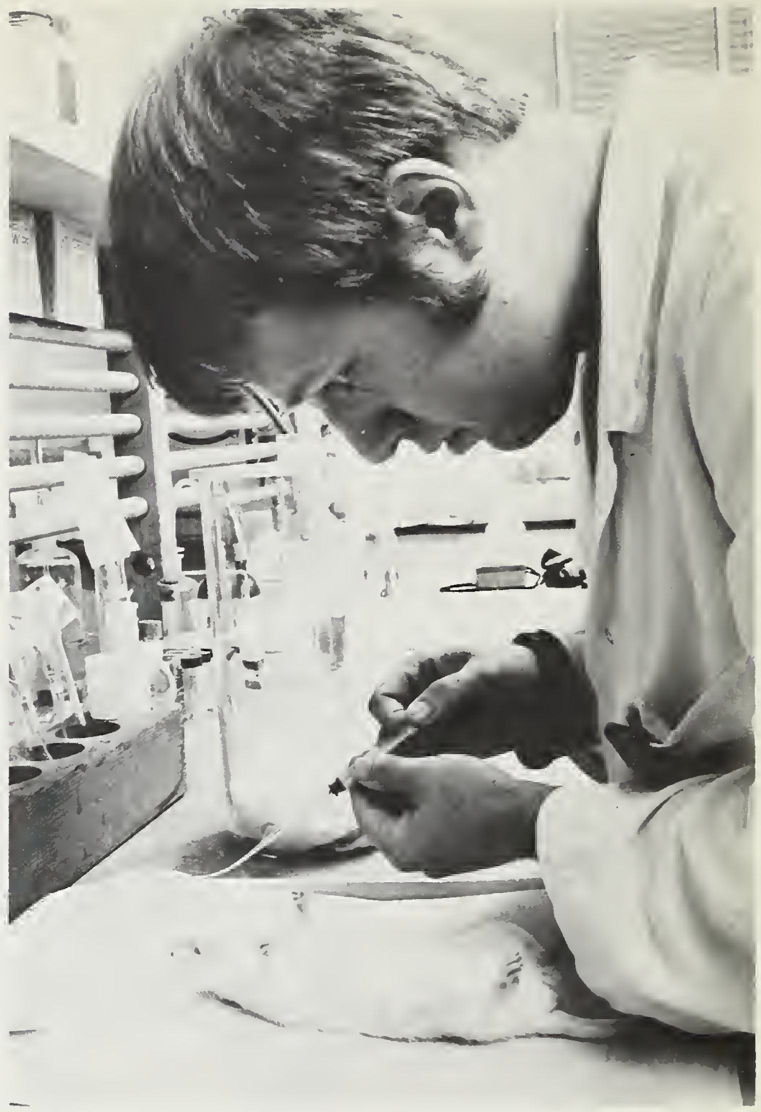
New light on zinc

TRACE ELEMENT deficiencies exist in the diets of substantial numbers of people throughout the world, as shown by scientific evidence accumulated over the past few years. These deficiencies can cause some major health problems.

For example, a deficiency of zinc in the diet can result in a poor sense of taste, delayed healing of burns and wounds, retarded growth of children, and delayed sexual maturity in adolescents. There is now evidence that infants, young women, institutionalized people, and some low-income people have marginal-to-deficient intakes of zinc.

Factors affecting the body's absorp-





***Above:** To determine the amount of the radioisotope in its body, the rat is placed in a whole-body counter. Heavy shielding on the counter prevents cosmic rays or other stray radiation from interfering (0875X1167–10). **Right:** Lab technician John R. Gross demonstrates an alternate method of dosing a rat with radioactive zinc—a stomach tube (0875X1168–30).*

tion and use of zinc and other minerals are being studied at the Plant, Soil and Nutrition Laboratory, Ithaca, N. Y., by plant physiologist Ross M. Welch, animal physiologist William A. House, and chemist Darrell R. Van Campen. Their experiments with rats indicate that some earlier conclusions about trace elements may warrant re-examination.

Several of their tests indicate that zinc is more available in immature peas and soybeans than in those harvested at maturity. Based on long-established research, it was not unexpected for the scientists to also find that the mature peas and soybeans contained six times more phytic acid (a metal-binding substance) than was found in the immature seeds. Under certain conditions phytic acid has a binding effect on zinc. Thus, the zinc in mature seeds would be expected to be excreted by the body, as a calcium-zinc phytate precipitate. Despite this expected effect, however, zinc in the mature peas and soybeans also had a high level of availability, although not as high as that of immature seeds.

One possible explanation for this result has been found in preliminary research which indicates that most of the zinc in mature legumes may be bound to certain sulfhydryl compounds instead of phytic acid. Thus, the zinc would not be percipitated by phytic acid and, therefore, its availability in certain foods may not be as limited as was previously believed.

Experiments to increase the concentration of zinc in peas and other crops have also been conducted in related research by agronomist David L. Grunes of ARS at Ithaca, and agronomist Nathan H. Peck, New York State Agricultural Experiment Station, Geneva. They applied zinc sulfate fertilizer (containing 36 percent zinc) to the soil in plots of peas and other vegetables. The plots received applications of 4.5, 18, and 72 pounds of zinc per acre. Zinc content of mature pea seeds averaged 61, 64, and 70 parts per million (ppm), respectively. When grown in nearby untreated plots, the seeds contained 53 ppm of zinc, or 15 to 32 percent less zinc than seeds grown in the test plots.

In contrast, solution culture experiments with iron did not increase the concentration of this mineral in soybeans or in the leaves of spinach or turnips. Nevertheless, these crops are good sources of iron.

Research data on the availability of iron, zinc, and other minerals is important in establishing realistic recommended dietary allowances (RDA) for people. Present RDA's for these elements may be too high if the research with rats is confirmed with people. □

Plague fights plague

A MODIFIED DC–3 flying at 300 feet dropped 68,000 pounds of specially treated wheat bran over 46,000 grasshopper-infested acres between Billings and Hardin, Montana. For the grasshoppers, it was a rain of death. For mankind, it was quite possibly the beginning of a new era in grasshopper control.

The wheat bran dropped from the airplane had been coated with a parasitic creature called *Nosema locustae*—which roughly translates to "grasshopper sickness." Hoppers eat the tasty bran flakes along with the *Nosema locustae*. The *Nosema* feeds on the hopper's fat and multiplies until the insect gets puffy, turns white, and dies.

"The aim of this project is to reduce the grasshopper population to tolerable levels," says ARS entomologist John E. Henry, of the Rangeland Insects Laboratory, Bozeman, Mont., the man chiefly responsible for this project.

Maintaining grasshoppers at a tolerable level will cut forage losses. More forage means more cattle which means more beef available for consumers. Stabilizing the cattle-carrying capacity of rangelands will contribute towards stabilizing beef prices at the market.

Dr. Henry's current study is the biggest experiment of its kind to date. It involves a total of 92,000 acres. In addition to the acreage treated with the bran and parasite, 23,000 acres will be sprayed with malathion insecticide, and 23,000 acres will not be treated. The different treatment areas will be carefully studied and compared for 3 years.

Nosema locustae was chosen over other, even more virulent, pathogens because *Nosema* is adaptable to standard application systems, thus easy to apply to fields. *Nosema* is a natural enemy of grasshoppers and in localized spots, often kills up to 90 percent of the hoppers it comes into contact with. ARS is simply taking this natural enemy and spreading it under controlled conditions.

To produce the deadly bran flakes, Dr. Henry first sprays a mass of lettuce with *Nosema*. He then feeds the lettuce to grasshoppers and usually manages to infest 99 percent of the grasshoppers he feeds.

The infected hoppers are then ground up, mixed with water, and aerosol-sprayed onto the wheat bran. One infected grasshopper will produce enough *Nosema* spores to treat 2 acres of land.

Initial results indicate that Dr. Henry and his research team have achieved a 70 to 75 percent infection rate on some *Nosema*-treated plots. He had only expected a 30 to 50 percent rate by this time. Infected hoppers will not lay eggs. They will die and the *Nosema* will be passed on to other hoppers.

Over the next 3 years, the grasshopper population on the treated fields should decline dramatically. New hoppers entering the fields will contract *Nosema* either from spores left in the grass from previous years' cadavers, or by feeding on the infected bodies of recently dead grasshoppers.

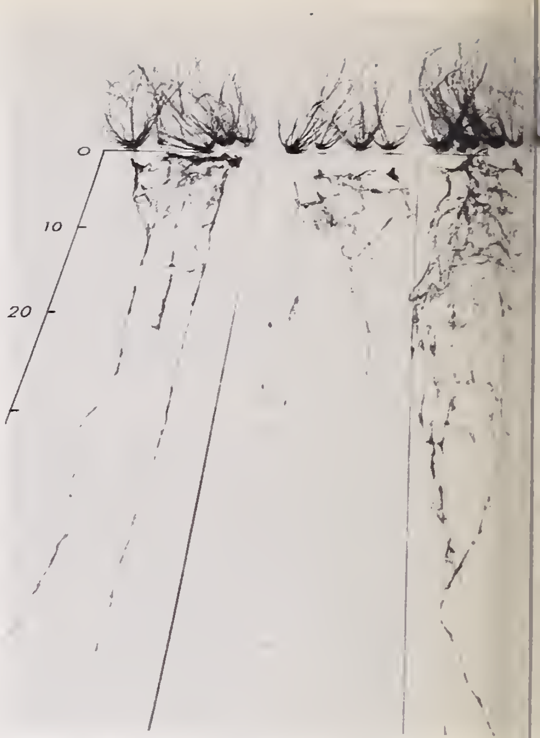
The *Nosema*-treated bran offers several advantages over chemical insecticides currently used to control hoppers. Unlike chemicals, *Nosema* does not kill every creature that comes in contact with it. *Nosema* only attacks hoppers and few species of crickets, including the Mormon cricket, another rangeland pest which is presently making a comeback.

Nosema is safer for people, does not build a resistance level in the insect, and lasts much longer than malathion. It may be 10 years before a new *Nosema* application is needed to control the hoppers on Dr. Henry's test fields. Finally, *Nosema* is much cheaper to use than insecticides. It is expected that use of *Nosema* will cost 25 to 30 percent of the cost of insecticide applications.

If successful—as initial results suggest—Dr. Henry's project could have world-wide potential. Many of the poorer, developing countries in Africa, and also India, suffer severe grasshopper attacks each year. Insecticides such as malathion are too costly, and because of the insects' migration habits, too impractical to use. Dr. Henry's control method offers these countries a relatively cheap and practical solution because grasshoppers infected with *Nosema* can't fly very far.

Dr. Henry hopes that USDA's Animal & Plant Health Inspection Service will eventually use parasite-coated bran flakes to treat Western rangelands and other hopper-plagued areas in this country.

Such a treatment would not eliminate grasshoppers entirely, Dr. Henry says, just hold their numbers down to a "live and let live" level. □



Dr. Wilson shows differences in blue grama seedlings. Plants at left have been restricted to the seed root, while plants on right have developed crown roots (0974X1531-6).

Bringing back blue grama

RECENT RESEARCH may enable blue grama grass to again become the predominant native forage on abandoned croplands of the central Great Plains. This perennial grass (*Bouteloua gracilis*) provides excellent grazing for cattle and thrives on the limited precipitation that the area receives.

To improve seedling survival, plant physiologist Alma M. Wilson of the Crops Research Laboratory, Ft. Collins, Colo., recommends practices designed to conserve soil moisture. Covering soil with a thin layer of straw may be helpful in some situations, he reports. Another practice is the elimination of weeds, especially during the early seedling stages.

Early homesteaders on the central Great Plains plowed up native sod only to abandon it later when they discovered there was insufficient moisture for grain crops. Ever since the dust bowl years, efforts to plant blue grama grass have almost always met with bitter failure.

ARS range scientist Donald N. Hyder discovered that blue grama is at a disadvantage on the arid rangelands because it begins growth differently than do crested wheatgrass, oats, and barley. All start growing by sending out a seed root. Crested wheatgrass also sends out several roots from the crown, which remains near the seed. Blue grama, however, elevates its crown to the soil surface by elongation of the subcoleoptile internode. This structure is very narrow and has difficulty supplying enough water for development of crown roots.

Adding to the difficulty of establishment, the seed root of blue grama can supply a maximum of only 2 milliliters (ml) of water per day to leaves. This amount of water is enough for early growth under ordinary conditions. Should 2 or 3 hot, windy days come along, however, the seedlings dehydrate and often die.

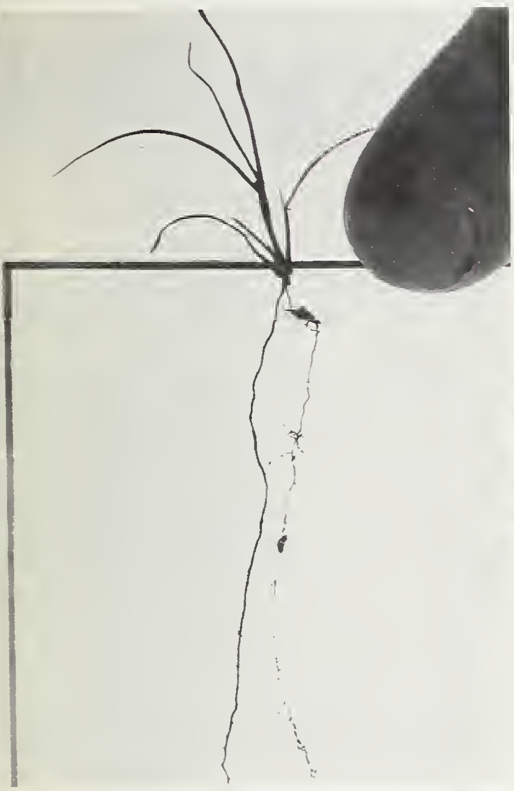
In contrast, if the seedling has developed just one crown root it can supply the plant's leaves with up to 10 ml per day. Consequently, survival of blue grama seedlings is not assured until one or more crown roots have extended into moist soil.

Soil at the depths where blue grama develops crown roots is usually dry, preventing root growth. The seedlings usually die 6 to 10 weeks after planting. Since the crown roots of crested wheatgrass develop near planting depths, weather effects are less severe.

Dr. Wilson is now using this information for developing methods to help select seedlings with superior drought resistance for use in plant breeding experiments. The methods may also be used for selecting other plants such as oats, wheat, and barley for dryland farming.

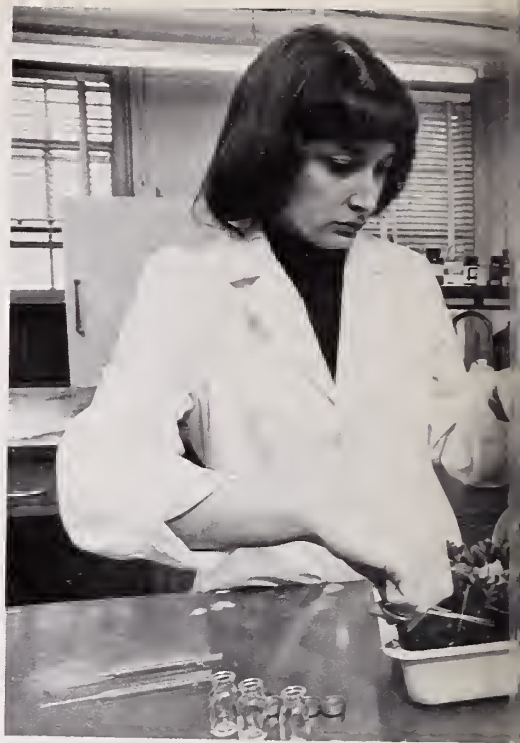
He is continuing this research project with the help of Dr. Hyder and Colorado State University graduate student David D. Briske. □

Under favorable greenhouse conditions, these blue grama seedlings have survived one year on only the seed root. Dr. Hyder discusses his research with former Deputy Director H. Rex Thomas (left), and Area Director C. E. Evans (right) (0974X1532–15).



Blue grama seedlings survive on the seed root (right) until conditions become favorable for development of one or more crown roots (larger root on left) (0974X1529–17).

Three-month-old blue grama grass. If the experiments are successful, blue grama will be introduced to abandoned homestead fields in the arid Central Great Plains to improve forage yields and quality (0974X1529–21).



Right: Laboratory technicians June L. Stanley and James W. Schwartz cut samples of cotton seedlings for weighing. Damaged seedlings on left were treated with test compound (1075X2139–13). Above: Weighing is one of the early steps in the long process of comparing the lipid components in the plant tissue (1075X2139–27).

Some like

COLD-HARDY PLANTS "put on their winter overcoats" through an experimentally determined internal chemical mechanism that could have practical implications worth many millions of dollars.

First, by pinning down key factors that explain cold hardiness in plants, scientists may be able to develop crop varieties tolerant to unseasonably low temperatures. Such varieties are needed to minimize substantial damage or losses resulting from the arrival of cold weather too early in the fall or frost too late in the spring.

A second potential for manipulating cold hardiness would be to use compounds that block the defense mechanism which permits weeds to survive at low temperatures. Frost would therefore finish off these weeds without use of conventional herbicides.

Control of weeds by such unconventional means, and the development of cold-hardy crops are the potential results of research directed toward entirely different goals. Six years ago, scientists at Beltsville, Md., introduced new herbicides related to a compound that has now been found to interfere with cold hardiness in plants.

The test compound, here called S–9785 for brevity, is 4-chloro-5-(dimethylamino)-2-phenyl-3 (*2H*)-pyridazinone. It is derived from pyrazon, a herbicide used against weeds in beets.

Experiments by plant physiologists Judith B. St. John and Meryl N. Christiansen at Beltsville show that S–9785 acts by preventing the roots from producing linolenic acid. This acid is a natural constituent that some scientists associated with cold hardiness in plants. Although this association has been a point of controversy for years, the experiments conducted by Dr. St. John and Dr. Christiansen provide substantial evidence that linolenic acid is a major factor governing cold hardiness.

Earlier experiments that did not support this conclusion had been made with mature plant tissue. In contrast, the Beltsville tests were made with the root tips. The scientists used cotton seedlings, which are susceptible to cold injury at temperatures of 50° F or lower.

In preparation for chilling tests, the scientists cold-hardened some of the seedlings by gradually reducing the temperature from 86° to 78°, then to 68°, and finally to 58° F. They then chilled the seedlings at 46° for 4 days.

Seven days after the chilling tests, the scientists found that none of the seedlings treated with S–9785 were normal when not previously cold-hardened. Forty percent of these

it cold

Above: Sample plants are ground prior to freeze-drying (1075X2139–34). Below: Mr. Schwartz removes a freeze-dried sample to begin extraction and identification of the lipid components in the plant tissue (1075X2138–11).

seedlings had died and 60 percent had abnormal cotyledons, that is, first leaves. Half of this leaf tissue was dead. Of the comparable untreated control group, 62 percent survived chilling as normal seedlings, as did 92 percent of the previously cold-hardened, untreated seedlings.

Of the treated and previously hardened seedlings, 20 percent had abnormal first leaves and 80 percent were normal.

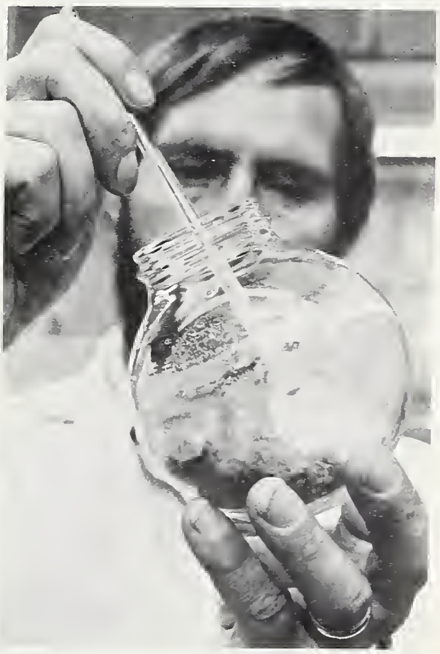
Longer periods of chilling might have increased the percentage of abnormal or dead seedlings.

In the untreated plants, linolenic acid content of the roots doubled when the temperature dropped from 86° to 58° F. Treated plants contained 55 percent less linolenic acid in the roots than did untreated plants at a temperature of 86° F. By the time the temperature fell to 58° F, treated plants' roots contained 63 percent less of this acid than did untreated plants.

Small amounts of S–9785 proved effective. The scientists mixed the compound in water and applied it at rates that provided 5 parts per million of the compound in the potting soil in which the seedlings were grown.

In the subsequent germination experiments, cotton seeds were wrapped in towels moistened with S–9785. Roots from the resulting seedlings were freeze-dried, then the linolenic acid content of the root tips was determined by chemical analysis.

Thus, from basic research come new concepts for improving crops and controlling costly weeds as well as contributions for developing conventional herbicides. □



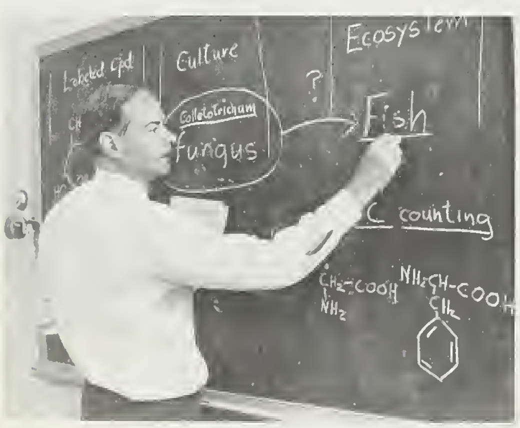
Tanks of Arkansas water containing fingerling bluegills are inoculated with radioactive fungal disease spores by Dr. Isensee (0775X1120–19A).

Micro-Ecosystem Monitors

DEVELOPMENT of practical ways to employ biological controls of weeds, insects, and other pests—as an alternative to conventional chemical pesticides—is likely to change the focus of concern over environment pollution rather than eliminate this issue.

This redirected concern will receive more public attention as research brings even more biological agents toward practical application. How accurately, in advance, can the effects of these biological agents on the environment be determined? To answer this question, a new protocol, or scientific system for testing biological agents in the aquatic environment, using a micro-ecosystem in the laboratory, has been devised by plant pathologist Allen R. Isensee and biochemist Philip C. Kearney, Pesticide Degradation Laboratory, Agricultural Environmental Quality Institute, Beltsville, Md.

Dr. Kearney traces the movement of carbon-14 through an aquatic ecosystem. Using carbon-14 to make the fungal spores radioactive allows the scientist to follow the spores' path in the food chain of fish (1075X2162–4).



In an evaluation of the new protocol, the scientists obtained encouraging results with fungus disease spores that are being tested as a biological agent to kill curly indigo. This weed, also called northern jointvetch, is a costly pest in rice paddies and drainage ditches in the South and other rice-producing parts of the world. The fungus, *Colletotrichum gloeo* (f. sp. *aeschynomene*), *sporioide* is lethal to this weed but does not harm other plants.

For environmental impact studies at Beltsville, water and soil samples from typical rice paddies were furnished by plant pathologist George E. Templeton, who, with research assistant J. T. Daniel, initiated research with the fungus at the Arkansas Agricultural Experiment Station, Fayetteville.

Dr. Isensee and Dr. Kearney evaluated the effects of the fungus with fingerling bluegills in four tanks, each containing about 4 gallons of the Arkansas water. Two tanks also contained 3.5 ounces each of an Arkansas rice-producing soil.

In preparation for the tests, Dr. Isensee and Dr. Templeton grew the fungus in a solution containing radioactive carbon.

The researchers then collected the spores and determined that the spores were radioactive and viable.

The radiation emitted by the spores, while of sufficient level to facilitate tracing the movement and effects of the organism, represents no hazard either to workers or to the environment when the material is discarded at the end of the experiment.

The scientists inoculated each tank with radioactive spores at a rate 10 times greater than that used for weed control to determine the effects of unexpectedly high releases of the organism in the environment.

The spores lost their viability after 3 days in the water. Within 1 day, 90 percent of the spores sank to the bottom in tanks that contained soil in the bottom. Eighty percent of the spores sank to the bottom during the same period in tanks containing no soil.

On the sixth day, only 8 percent of the spores could be detected by a radiotracer analysis made just above the soil surface at the bottom of the tanks. The deterioration of the spores would likely be more rapid in natural conditions because rice waters are substantially warmer than the 68°F water used in these tests.

No significant increase in radiation occurred in the bluegills during the 6-day tests. Results indicated that the radiation analyses provide more sensitive measurements of the effects of biological agents than is available from colony counts of fungi. The experiments also demonstrate that the artificial micro-ecosystem can provide precise information on the fate of biological control agents in an aquatic environment, and could be used to evaluate the safety of other beneficial pathogens.

The micro-ecosystem tests provide a critical indication of whether a control agent is likely to get in the food chain and accumulate in certain aquatic organisms. This unwanted effect can be expected if the organism survives in small fish, which are common prey of larger fish, birds, and animals—thus becoming more concentrated in larger predators and man.

Results of the Beltsville tests give further encouragement for the potential practical applications of the fungus in weed-infested rice paddies. Earlier tests by Dr. Templeton, Mr. Daniel, ARS agronomist Roy J. Smith, Jr., and Experiment Station research assistant William T. Fox showed that the weed-killing fungus has no harmful effects on 15 different crops.

During 6 years of research with the fungus, workers have experienced no allergies or other undesirable effects. Ill effects on man or domestic and wild animals would be unexpected because the organism cannot live at the body temperature of warm-blooded animals. Moreover, this fungus belongs to a genus that has never been implicated as a source of toxic materials. □

TROJAN HORSE

An attack from within has proven to be an effective strategy in the battle against an enemy that first invaded the United States about 1890 and causes a loss of many millions of dollars per year: the horn fly.

The horn fly is one of the most destructive insects of the livestock industry. Uncontrolled, the blood-sucking pest may attack cattle in numbers of 3,000 and more per cow, reduce the output of dairy cattle as much as 20 percent, and prevent weight gains of beef cattle by as much as one-half pound per day.

As part of a pilot program to study the feasibility of eliminating the horn fly from an isolated area, a multidisciplinary ARS research team from the U.S. Livestock Insects Laboratory at Kerrville, Texas, conducted a 6-week test at Kalaupapa peninsula, Molokai, Hawaii, to study the effectiveness of methoprene administered to the drinking water of cattle in suppressing the horn fly.

Adding methoprene, an insect growth regulator, to the drinking water of cattle effectively reduces the adult population of the horn fly and prepares the way for the release of sterile males which mate with the remaining fertile females. These females then lay infertile eggs which fail to hatch, further reducing the insect population.

Adding the growth regulator to the drinking water has two major advantages over conventional dermal applications: the cows do not have to be rounded up for treatment, and the sterile males released later do not die from the insecticide residues on the cattle before they have a chance to mate.

The research team found through the examination of manure samples that the development of adult horn flies was effectively inhibited when approximately 0.3 parts per million of methoprene (about 3 drops of a 2 percent solution per gallon of water) was added to the cattle's drinking water. Previous tests had indicated that cattle would readily drink water containing methoprene and that a daily consumption of 0.7 milligram of the insect growth regulator was 100 percent effective in inhibiting horn fly emergence. Furthermore, no toxic effects were observed from the chemical, even when cattle were given larger dosages for longer periods of time.

For the test, the scientists constructed special metering devices which automatically added the correct amount of methoprene to the drinking water of 350 cattle. An untreated group of 12 cattle served as a control. The number of flies per cow declined from an average of 360 to 7, and the number of horn fly eggs decreased from an average of 75 to 13 per manure dropping during the 6-week experiment. The number of horn flies and eggs that remained were attributed to reinfestation by flies from the untreated control animals and migration from outside the test area.

The results of the test clearly show that methoprene in the drinking water can greatly reduce the horn fly population, even in a semi-isolated area, and that combining this treatment with the sterile male technique might provide an effective approach to total elimination of a population.

Testing of this approach to elimination has been expanded over the whole island of Molokai. □

A super slurper flake swells to a chunk that is over 99 percent water—like a soft, rubbery ice cube that is not cold. Super slurper, made as film, flakes, powder, or mat absorbs 1,400 times its weight of liquid (0975R1878-20A).

An Honor for Super Slurper

An airline traffic manager wants to try super slurper for absorbing wastes from livestock cargoes. He was referred to ARS by a paper manufacturer.

The request illustrates the application range—wastes to paper to aviation—that helped the agricultural research development win recognition by *Industrial Research* magazine as one of the 100 most significant new products in 1975.

The airline request, one of more than 1,000 for research samples, coincided with the magazine's congratulations to the Northern Regional Research Center team, chemists M. Ollidene Weaver, George F. Fanta, William M. Doane, and Edward B. Bagley.

The purpose of the *Industrial Research* annual I•R 100 program is "to recognize innovators and organizations for outstanding practical technical developments and to identify significant technological advances of interest to scientists and engineers." The judges are the magazine staff and the advisory board. The board is composed of internationally known scientists and engineers, inventors and research administrators, and includes a Nobel laureate.

The award-winning super slurper absorbs 1,400 times its weight of distilled water. It congeals water to a gel that is like a soft, rubbery ice but not cold. Water in this semisolid state is easier to handle than a liquid in fluid-control applications from diapers and bandages to fire fighting and sandy soils. The semisolid water is easier than liquid to move or hold in place (AGR. RES., June 1975, p.7).

The water-slurping product is made by a technique called grafting, described by Charles R. Russell, cereal products research leader, as "one way of making industrial chemicals from starch that is in excess of food needs and thus extending limited petroleum resources." Starch, obtained from corn or some other farm crops, is combined with acrylonitrile, manmade from petroleum chemicals. This combination, half starch, a natural polymer, and half man-made polymer of acrylonitrile, is treated with lye to produce what is chemically identified as a hydrolyzed starchpolyacrylonitrile graft copolymer.

The main reason it is called a super slurper is that it takes up so much water so fast—1,400 times its own weight, half in 30 seconds and most of it in 10 minutes.

It absorbs and holds 50 to 100 times its weight of mineral solutions such as

simulated urine or hard water. In tests of absorbents for diapers, super slurper shows 20 times the urine-holding capacity of cellulose (cotton, for example) against a force 45 times gravity.

Super slurper is made as film, flakes, powder, or mat. These forms take up water, swelling but not dissolving, and hold it in expanded duplications of their own dry shapes. Films extend and thicken to sheets. Powders become piles of water textured like crushed ice. A flake expands to a clear, angular piece of water.

The swollen forms shrink in dilute acid, expand again in dilute alkali solution. They also shrink as they dry and expand again with water.

The slurper, with these properties, can be mixed with or coated on all kinds of materials including, for example, sand, straw and sawdust, seeds and roots, natural or synthetic fibers, and flour, gelatin, and starch. It can hold water in soils, animal bedding and kitty litter, toweling and diapers, bandages, surgical pads, and dental absorbents.

Northern Center studies suggest use of super slurper as a binder in sand molds for metal castings and to hold sandy soil surfaces against wind erosion. Slurper aided the growth of oats and grass in sand in Iowa State University studies. Oats planted in a slurper-sand mixture lived 11 days longer than oats in sand alone and produced 10 times as much top growth. Fescue grass grew on slurper-treated sand banks of a waterway but did not survive dry soil conditions where super slurper was not used.

The Northern Center team used the new starch product to extract water and concentrate solids of milk and oil-water emulsions and to separate proteins from water.

The team also demonstrated that super slurper can gel water for easier handling in industrial and animal wastes, mud, and sewage sludge. The team converted sludge, for example, to a crumbly material that could be scooped and trucked instead of pumped and wouldn't run off when spread.

Super slurper could be used to aid retention of starch in paper, to immobilize enzymes, reducing their loss in industrial fermentations, and to encapsulate fertilizers.

A modified slurper takes up mixtures of water and solvents such as ethyl alcohol, wood alcohol, and acetone. Uses for this solvent slurper might be found in paint strippers, wallpaper cleaner, spot removers, and other applications for handling organic solvents as well as water.

Samples of super slurper are available for end-use studies from the Northern Regional Research Center, Peoria, Illinois.

Similar materials are also available from General Mills, Inc., Minneapolis, Minn. General Mills, one of seven companies that have licensed a USDA patent application, has agreed to service industrial requests. □

The award-winning team, Ms. Weaver, Dr. Doane, Dr. Fanta, and Dr. Bagley (left to right), look at super slurper from a different angle. Super slurper has many potential applications wherever there is a need for a new way to handle liquids (0975R1879–5).

Dr. Fanta and Ms. Weaver demonstrate that a single thickness of cheesecloth can hold water—if it has been super slurped (0975R1881–5).

Soil scientist Rasmussen watches as within-row irrigated beans are checked. Soon, the furrows will be reformed and the beans will be conventionally irrigated until harvest (0874X1357-11).

New technique saves irrigation water

BEAN FARMERS can reduce by 30 to 50 percent the amount of water they now use each season for irrigation by adopting a new within-row irrigation technique.

Beans grown in semi-arid areas are planted late in the spring to avoid frost. It is necessary to irrigate prior to planting to provide moisture for germination. With conventional irrigation practices it is not uncommon to wet the entire soil profile, applying as much as 12 inches of water.

Much of this water is lost to deep percolation and evaporation. Moreover, the soil in bean-growing areas is usually loose and highly susceptible to erosion. The frequent irrigations and large volume of water used in conventional irrigation practices often cause considerable erosion in bean fields.

According to soil scientist Warren Rasmussen and agricultural engineer Robert Worstell, of the Snake River Conservation Research Center, Kimberly, Idaho, the quantity of water needed to establish satisfactory stands and subsequent growth of beans, can be almost cut in half.

By applying water with a multi-set surface irrigation system to small listertype furrows—which resemble corrugations—the ARR researchers apply only about 1/8 of the water generally used in conventional, pre-plant irrigation.

The use of multi-set surface irrigation systems enable the application of small quantities of water at controlled rates to small areas of soil around the furrows. The average depth of water applied to furrows by the researchers during pre-plant irrigation was a mere 1.5 inches.

The researchers use an ordinary surface planter to seed beans directly into the damp furrows 2 to 3 days following the pre-planting irrigation. After the beans emerge and while the plants are still small, frequent, light irrigations are applied directly around the beans growing in the lister furrows. At the last cultivation, standard irrigation furrows are reformed in the centers between the rows of bean plants and are irrigated in a conventional manner until harvest.

By continuing within-row irrigations while the plants are small, only 0.5 to 1.5 inches of water are applied to the furrows each irrigation. In total, only 14 to 16 inches of water are applied to bean plants each season. Conventional irrigation methods average 22 to 28 inches of irrigation water each season.

Besides reducing the amount of irrigation water used, the researchers also significantly reduced soil losses by furrow erosion and runoff, and to a lesser extent, cut nitrogen losses with their new irrigation technique. □

AGRISEARCH NOTES

Yearbook: That We May Eat

CONTRIBUTIONS made to consumers by the Nation's state agricultural experiment stations—from the discovery of vitamins to the creation of hybrid corn—are featured in *That We May Eat*, the 1975 Yearbook of Agriculture.

Consumers, students, and the general public will find this Yearbook, written in a popular style, easy to read. It gives insight into the fascinating search for ways to help increase food and fiber supplies and provide a better life for consumers.

The Yearbook, which chronicles 100 years of achievements by state agricultural experiment stations, includes historical agricultural information stretching back to colonial days. George Washington, for example, was the Nation's first mule breeder, using a jack and jennets sent him by the King of Spain as his basic, experimental stock.

A 19th century Connecticut pathologist wrote his initials on a potato with paste from a fungus he believed caused potato scab, according to the Yearbook. When he dug the potato in the fall, he found his monogram neatly etched by the obliging fungus, proving his point.

Secretary of Agriculture Earl L. Butz notes that the development of a vaccine to protect poultry from Newcastle Disease is a striking example of the payoff from agricultural research. The estimated worldwide economic value of this research done at the Virginia Agricultural Experiment Station is $1 billion, according to Dr. Butz.

Copies of *That We May Eat* may be purchased for $7.30 each from government bookstores or by sending a check or money order to: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Members of Congress have a limited number of copies for free distribution to constituents.

Quicker Check for Root Rot

A RAPID TECHNIQUE has been developed for screening pea cultivars or breeding lines for resistance to *Fusarium* root rot, one of the most serious pea diseases.

Processing peas are grown from coast to coast with the heaviest concentrations in the Midwest and the Pacific Northwest. Wherever peas are grown, there is *Fusarium* root rot, and if environmental conditions favor the disease, pea yields can be reduced by 30 to 40 percent. For a crop that is often as marginal as peas, such a loss is disastrous. Understandably, farmers want to plant only those pea varieties that are known to be resistant to root rot.

The new screening technique developed by ARS plant pathologist John M. Kraft, Prosser, Wash., may help. It is superior to other techniques because test lines can be evaluated for root rot resistance at a younger age. Therefore, a higher percentage of resistant transplants survive to set seed.

In employing Dr. Kraft's technique, test line pea seeds are surface-disinfected with a 0.3 percent sodium hypochlorite solution. Two lines, 25 seeds from each line, are then planted in flats filled with uncropped fine sandy loam soil artificially and heavily infested with the *Fusarium* root rot organism (20,000 to 40,000 propagules per gram of soil).

Seeded flats are placed in a growth chamber illuminated for 12 hours daily with 1,100 foot-candles of light. Day temperature is 23.9° C and night temperature 18.4° C, plus or minus 1 degree. Flats are watered as necessary.

Six days after emergence, seedlings are carefully removed from each flat, then the soil is washed away from the roots. Next, seedlings are rated for root rot resistance. Seedlings with healthy roots are transplanted into a fumigated potting mixture of 1 part soil, 1 part sand, and 1 part moss, and grown to seed set.

Results from this technique have been reproducible. Pea lines surviving Dr. Kraft's screening process proved resistant when grown in fields heavily infested with root rot. So thorough is Dr. Kraft's technique that several plant introduction pea accessions previously reported as resistant to root rot were found to be susceptible.

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AGRISEARCH NOTES

Spaced-Out Cows Swear Off

WE'VE got to keep the cows off the grass—sleepy grass, that is.

Growing green and luscious on millions of acres in the high country of the Southwest, sleepy grass (*Stipa robusta*) is a plant with narcotic-like effects that drugs cows, sheep, and horses. Horses, in fact, have been known to doze for as long as 7 days after grazing on it. An early report tells of the deaths of several members of a survey party whose horses slept through an Indian attack.

Sleepy grass is now primarily a problem with cattle, and ARS veterinary medical officer Harry E. Smalley has found a way to solve it. In tests conducted on the mountain ranges of New Mexico, he found that when cattle were fed sleepy grass, although they ate it with gusto, the first time was the last. The cows would not touch it again once they had experienced its effects, which included a kind of catatonia as well as sleepiness. The animals would "freeze" in one position—with a hoof raised, for example—and remain absolutely still, oblivious to pestering flies, for as long as 45 minutes.

But the fact that the cows swear off after the first binge is important to ranchers. They could feed their herds sleepy grass hay, under controlled conditions, perhaps once before moving them up into the hills. The cattle should then avoid the grass and would not be down for days nor be spaced out and losing weight. An added benefit of this prefeeding is that the grass acts as a tranquilizer and calms the cattle down for the trip.

Two large ranchers who have tried the method report that it works well.

In testing the effects of sleepy grass on sheep, the scientists found results similar to those for cattle; however, the sheep were not as strongly affected as the cows. Analysis identified the narcotic-like substance as diacetone alcohol.

Mothproofing Woolens

SYNERGIZED PYRETHRINS were an effective mothproofing agent for woolens in tests conducted at the Stored-Product Insects Research and Development Laboratory at Savannah, Ga.

In the tests, woolens sprayed with as little as 0.25 percent pyrethrins synergized with 1 percent piperonyl butoxide protected wool cloth from larvae of both the webbing clothes moth and the black carpet beetle during an entire 6-month test period.

The combination of pyrethrins and piperonyl butoxide as an insecticide is not new. It has been widely used against many household insects, partly because of its low level of toxicity to humans and animals. Until now, however, it has not been looked at as a seasonal mothproofing agent for woolens, according to entomologist Roy E. Bry and chemist Richard A. Simonaitis who conducted the tests.

Based on the results of the tests, three formulations of pyrethrins and piperonyl butoxide were recently registered by the Environmental Protection Agency as 6-month mothproofers and should soon be available for public use.

When reporting research involving pesticides, this magazine does not imply that pesticide uses discussed have been registered. Registration is necessary before recommendation. Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—If not handled or applied properly. Use all pesticides selectively and carefully.

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